AYDIN
ADNAN MENDERES UNIVERSITY
FACULTY OF ENGINEERING
Department of Electrical and Electronics Engineering

EE214 – Computer Aided Engineering Applications

Prof. Dr. Yılmaz KALKAN

EE214 – Computer Aided Engineering Applications

Lecture 1

INTRODUCTION

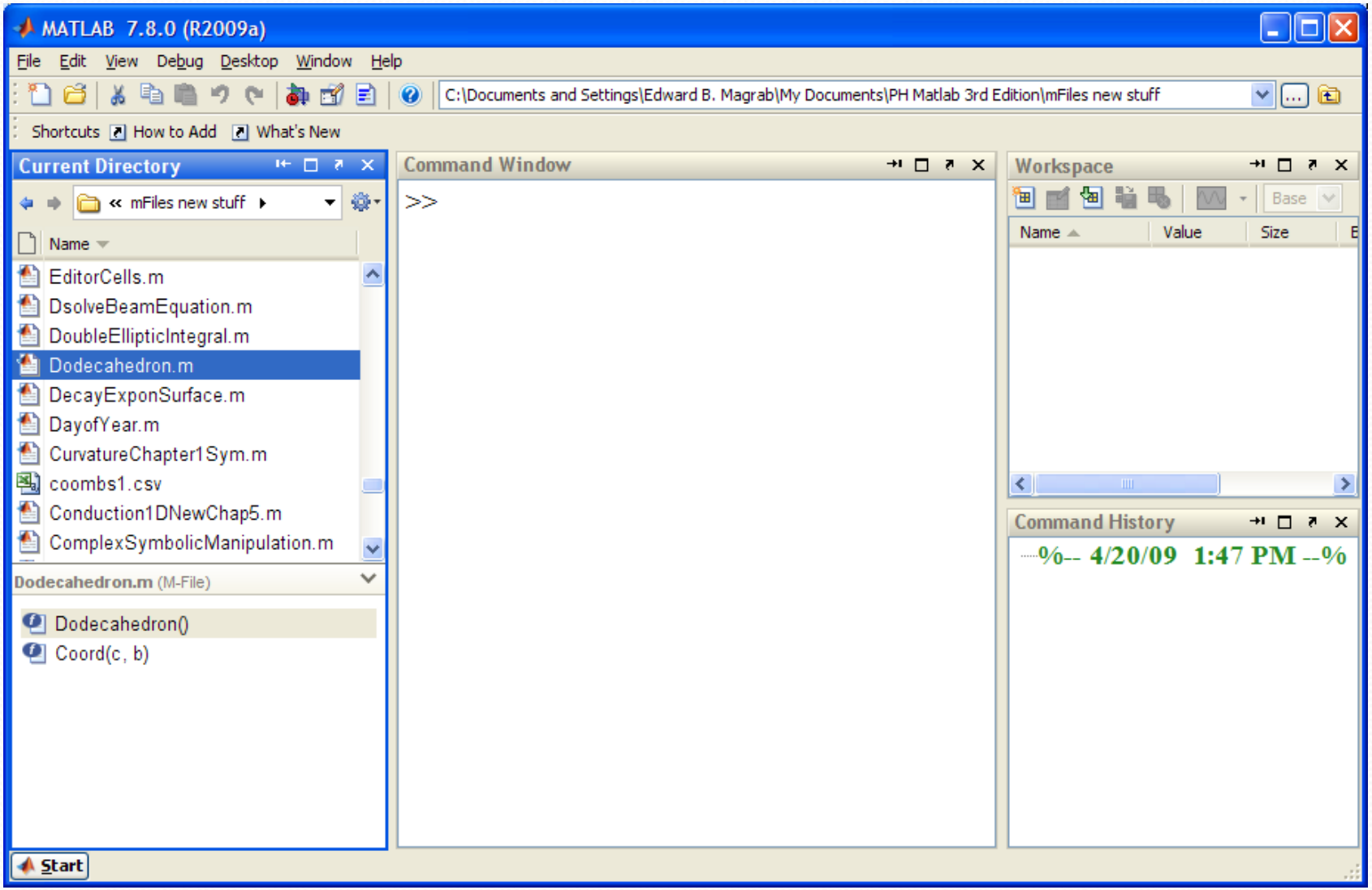
MATLAB

- A computing environment devoted to processing data in the form of arrays of numbers (matrices, vectors). Derives its name from *MAT*rix *LAB*oratory.

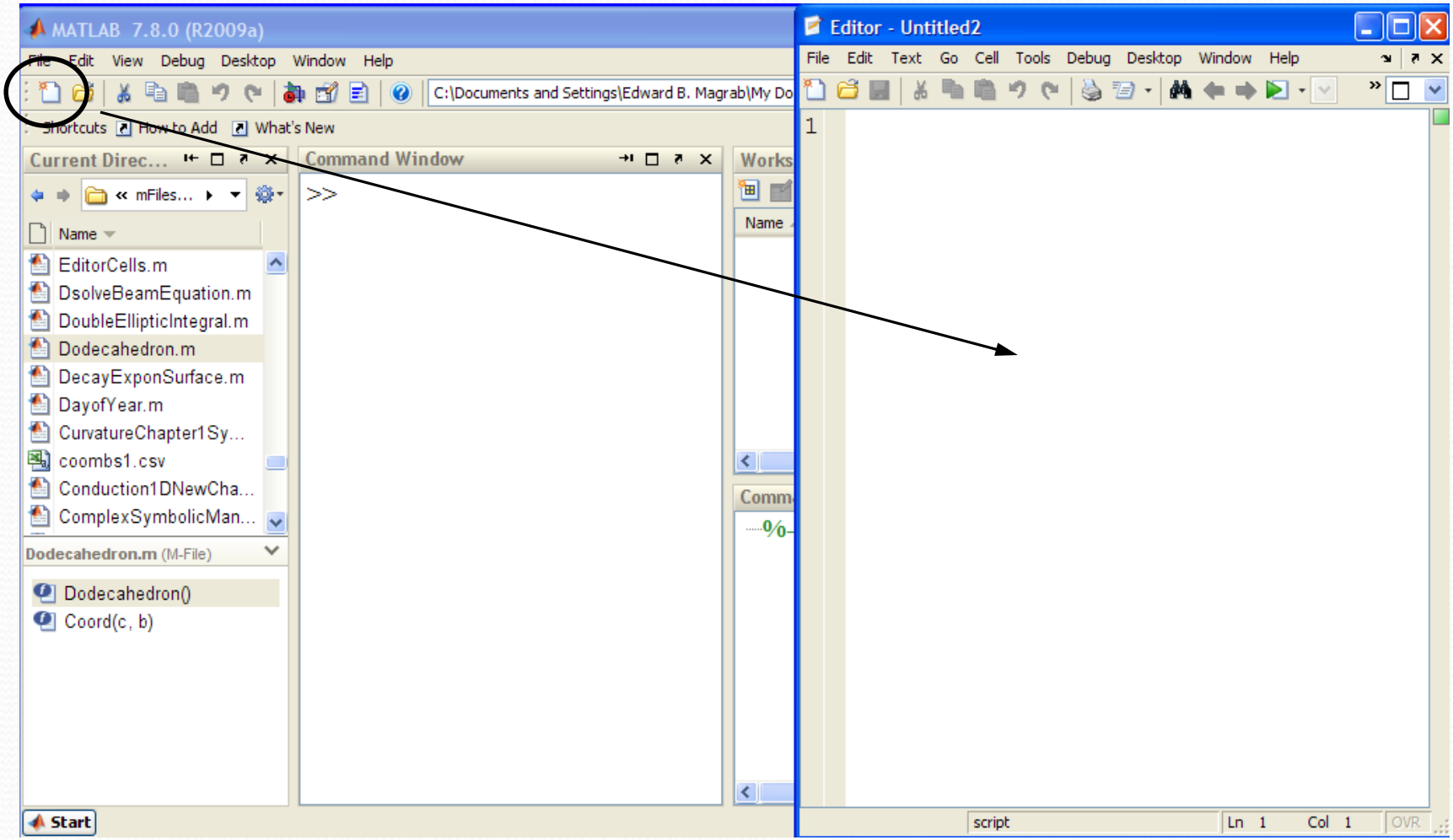
- It provides built-in functions, toolboxes for different purposes; engineering applications (analysis, design), finance-statistics.

- Whole system is based on MATLABs unique programming language

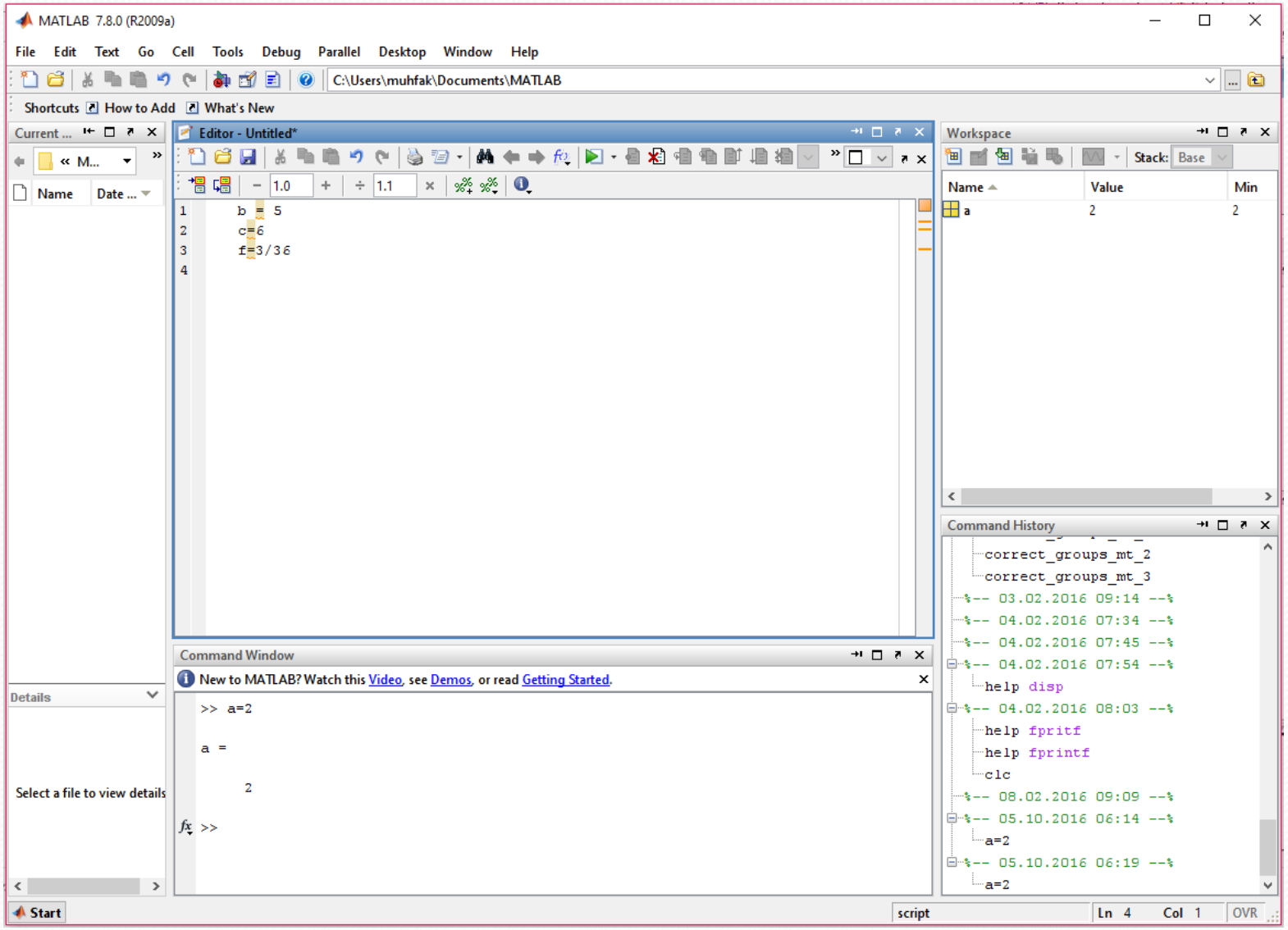
Command Window, Command History, Workspace



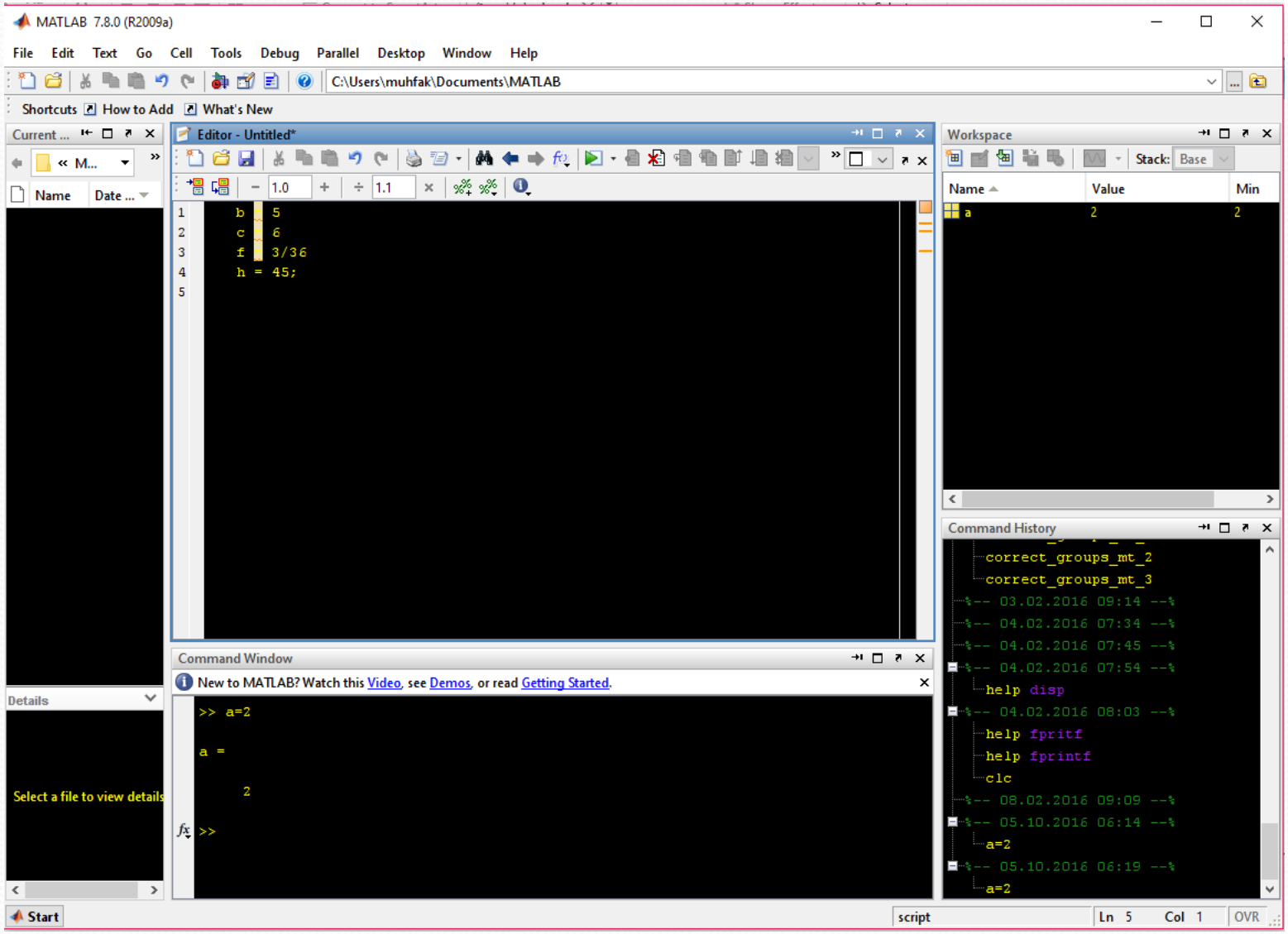
Command Window, Command History, Workspace, and Editor



Command Window, Command History, Workspace, and Editor



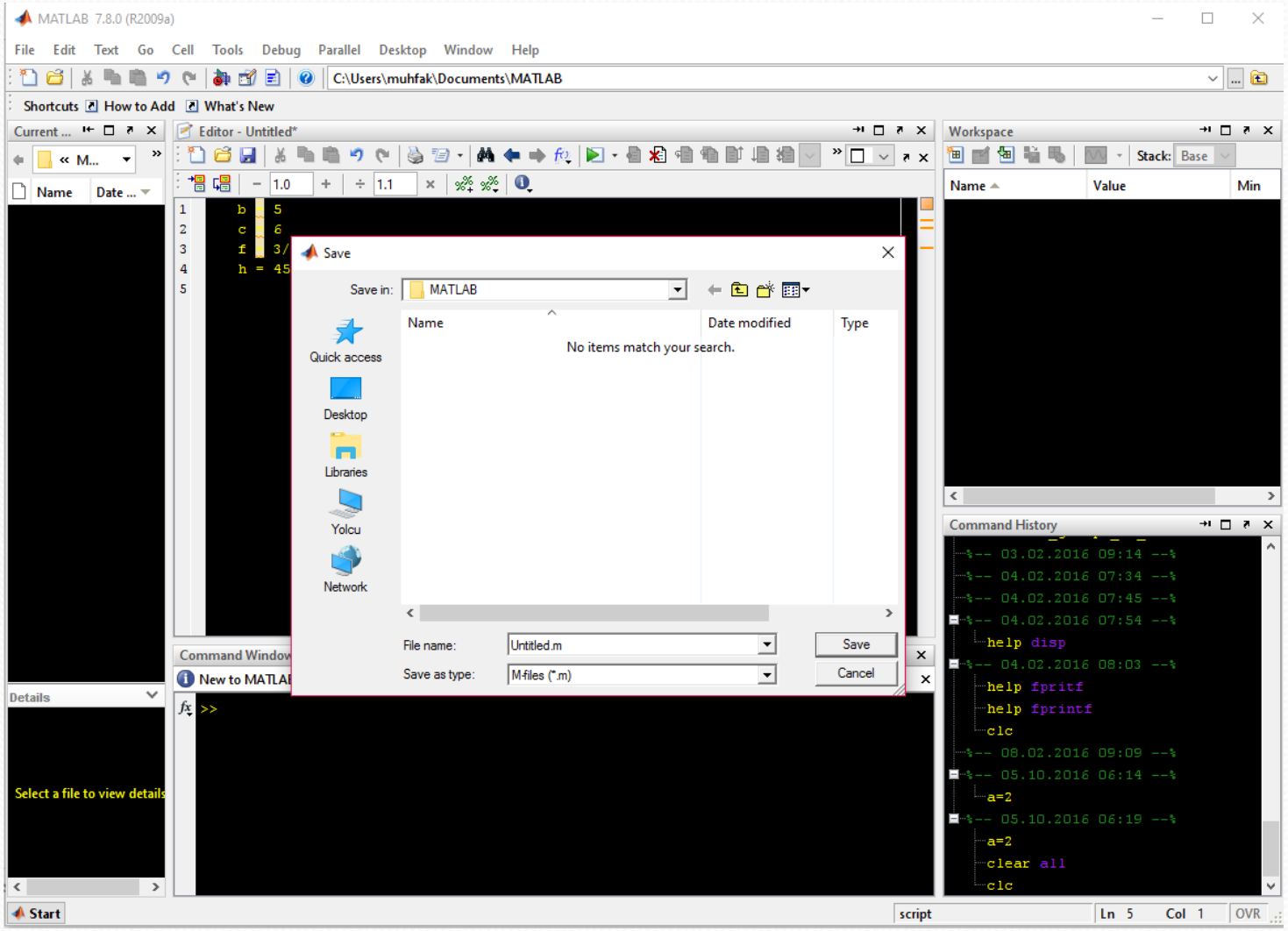
Command Window, Command History, Workspace, and Editor



Clearing of Command Window and Workspace

MATLAB function	Description
clc	Clear the command window
clear	Removes variables from the workspace (computer memory)
close all	Closes (deletes) all graphic windows
format	Formats the display of numerical output to the command window
format compact	Removes empty (blank) lines

Command Window, Command History, Workspace, and Editor



MATLAB Variables

- 63 characters (case-sensitive alphanumeric ch. with '_')
- Start with uppercase or lowercase letter

  Followed by any combination of uppercase and lowercase letters, numbers, and the underscore character (_) . No blank! ('jun k' is not a proper name)

  Case sensitive, *junk* different from *junK*

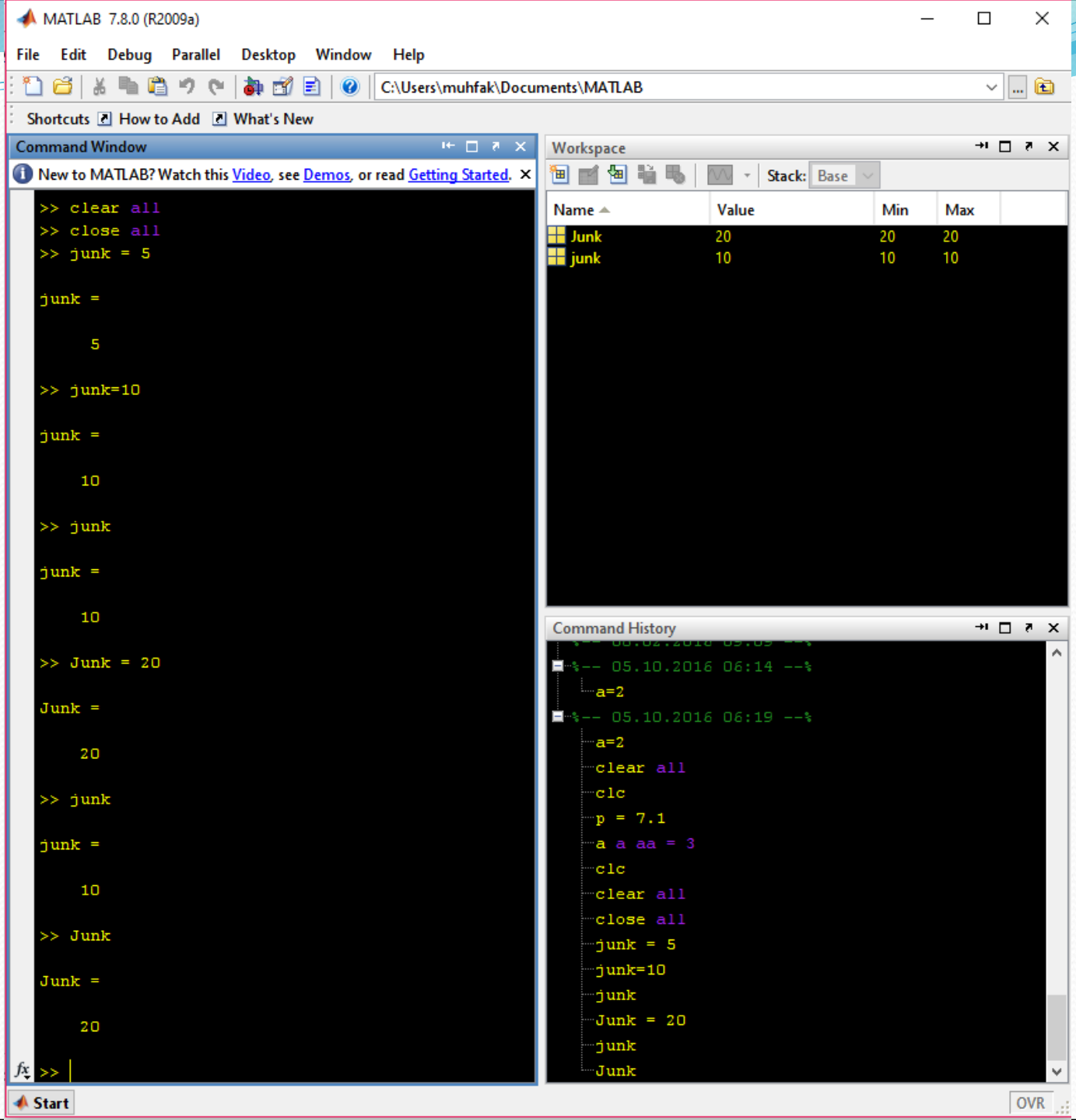
- Example:

  exit_pressure or *ExitPressure*

- Length of variable names

  Tradeoff between easily recognizable identifiers and readability of the resulting expressions.

MATLAB Variables



Command Window Interaction

```
» p = 7.1
p =
    7.1000
» x = 4.92
x =
    4.9200
» k = -1.7
k =
   -1.7000
```

← User types and hits *Enter*

← System response

← User types and hits *Enter*

← System response

← User types and hits *Enter*

← System response

Suppression of System Response – Semicolon

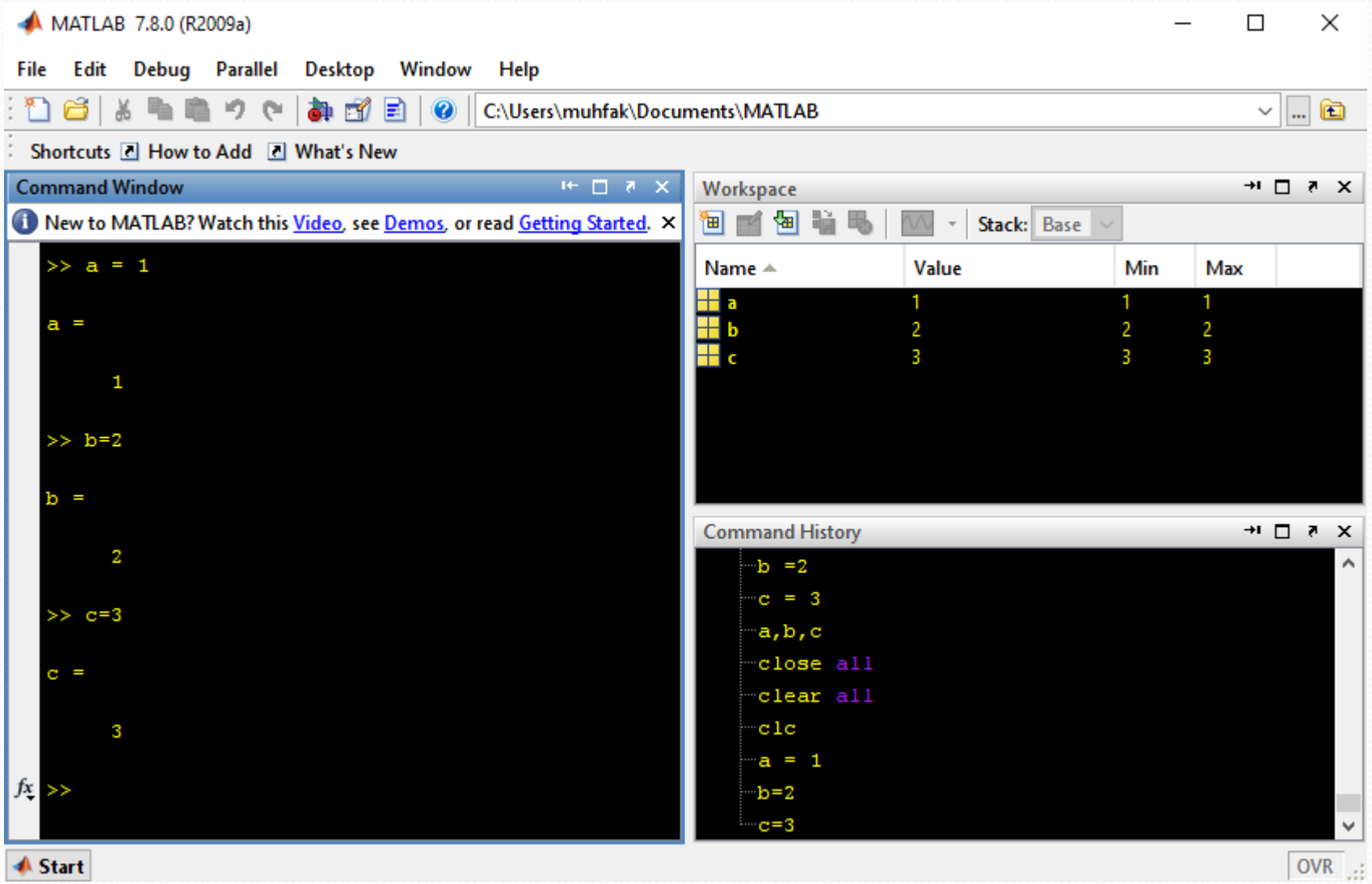
```
» p = 7.1;
» x = 4.92;
» k = -1.7;
»
```

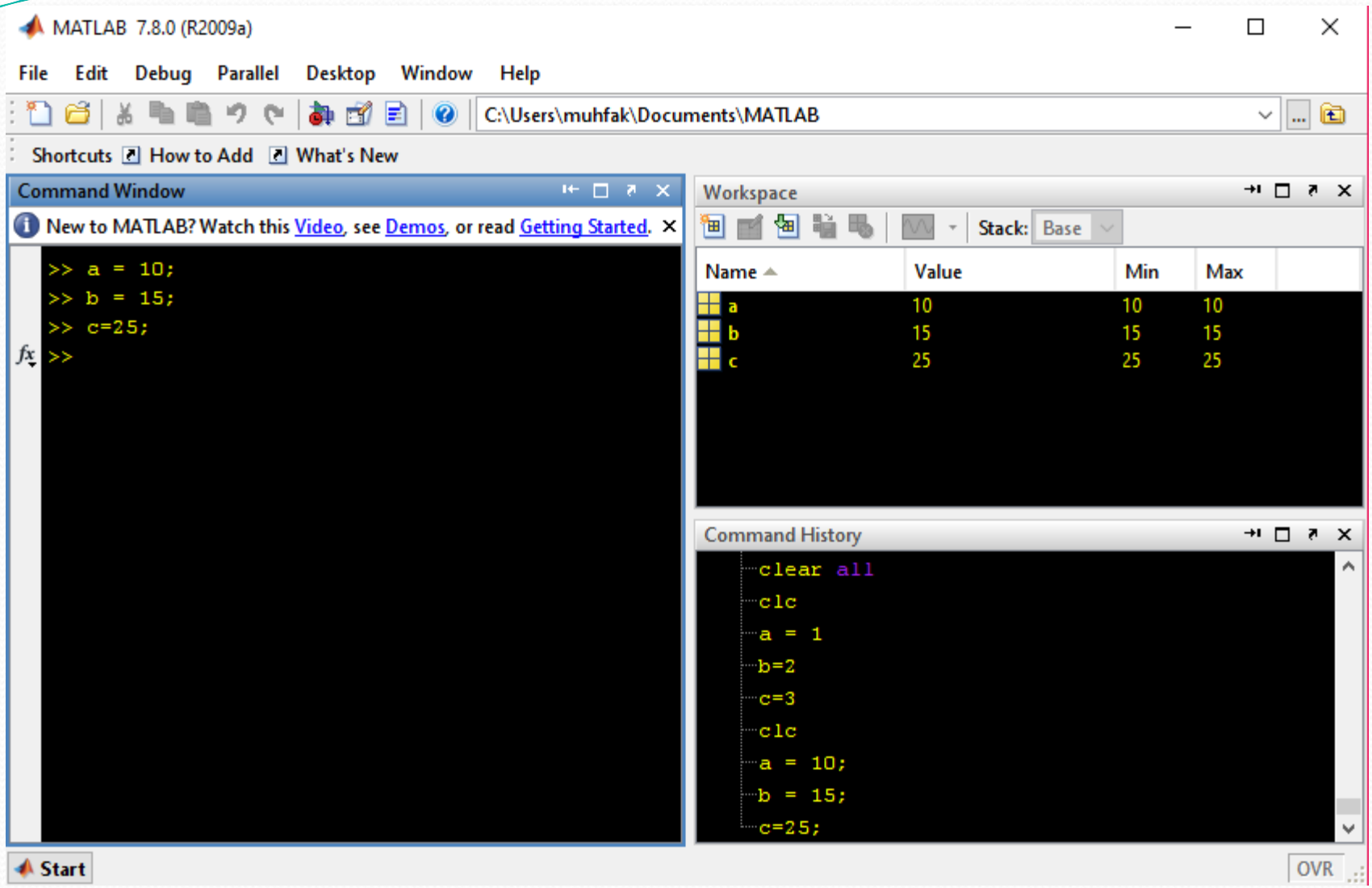
Several Expressions Placed on One Line

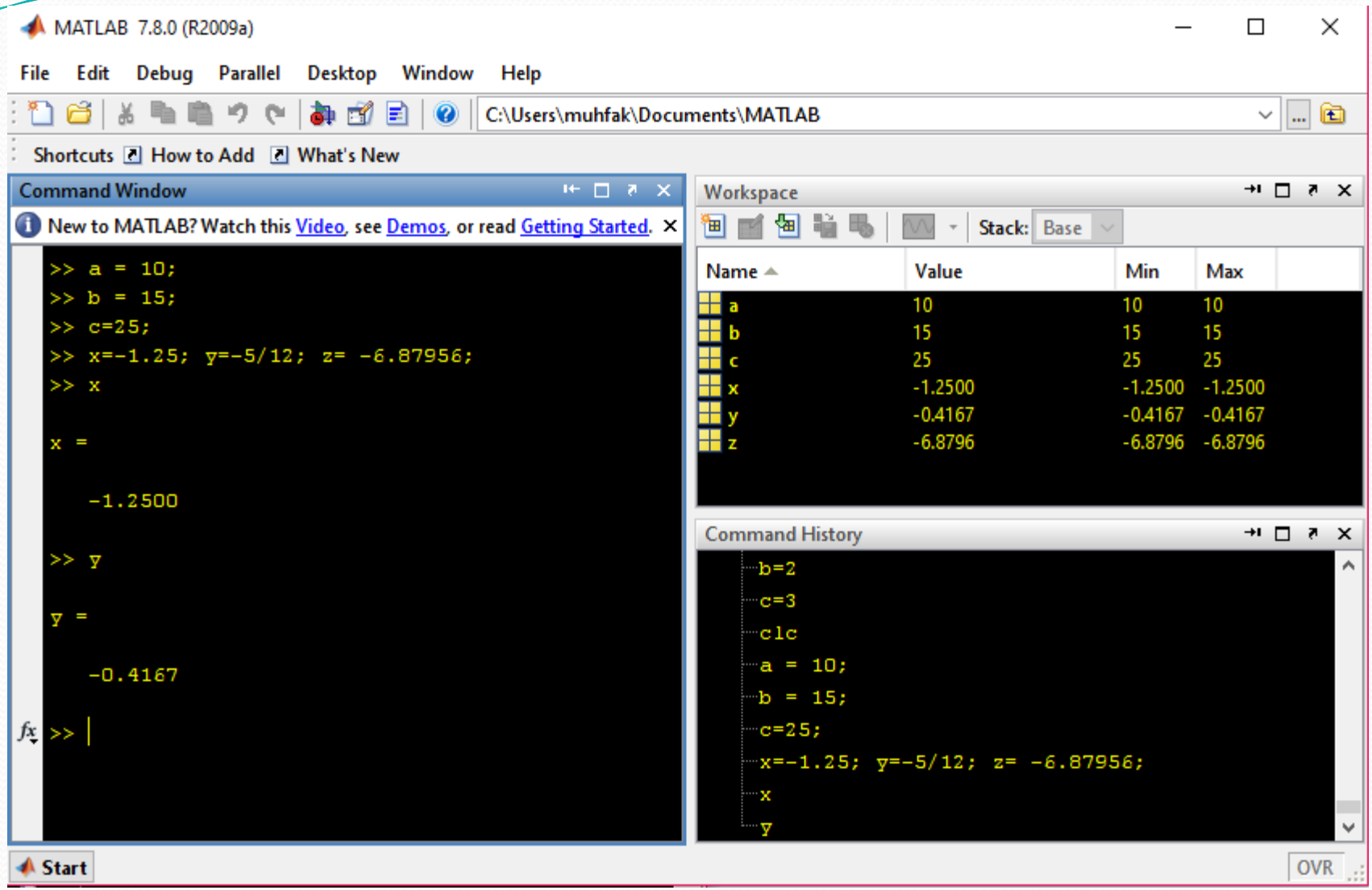
```
p = 7.1, x = 4.92, k = –1.7

System response –
    p =
        7.1000
    x =
        4.9200
    k =
        -1.7000
    »
```

Using semicolon instead of commas suppresses this output


MATLAB 7.8.0 (R2009a)
File Edit Debug Parallel Desktop Window Help
C:\Users\muhfak\Documents\MATLAB
Shortcuts How to Add What's New
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.
>> a = 1
a =
1
>> b=2
b =
2
>> c=3
c =
3
>>
Workspace
Stack: Base
Name Value Min Max
a 1 1 1
b 2 2 2
c 3 3 3
Command History
b =2
c = 3
a,b,c
close all
clear all
clc
a = 1
b=2
c=3
Start
OVR


MATLAB 7.8.0 (R2009a)
File Edit Debug Parallel Desktop Window Help
C:\Users\muhfak\Documents\MATLAB
Shortcuts How to Add What's New
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.
>> a = 10;
>> b = 15;
>> c=25;
>>
Workspace
Stack: Base
Name Value Min Max
a 10 10 10
b 15 15 15
c 25 25 25
Command History
clear all
clc
a = 1
b=2
c=3
clc
a = 10;
b = 15;
c=25;
Start
OVR


MATLAB 7.8.0 (R2009a)
File Edit Debug Parallel Desktop Window Help
C:\Users\muhfak\Documents\MATLAB
Shortcuts How to Add What's New
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.
>> a = 10;
>> b = 15;
>> c=25;
>> x=-1.25; y=-5/12; z= -6.87956;
>> x
x =
-1.2500
>> y
y =
-0.4167
>>
Workspace
Stack: Base
Name Value Min Max
a 10 10 10
b 15 15 15
c 25 25 25
x -1.2500 -1.2500 -1.2500
y -0.4167 -0.4167 -0.4167
z -6.8796 -6.8796 -6.8796
Command History
b=2
c=3
clc
a = 10;
b = 15;
c=25;
x=-1.25; y=-5/12; z= -6.87956;
x
y
Start
OVR

Arithmetic Operators

		Hierarchy Level
( )	Parentheses	1
´	Prime (Apostrophe)	1
^	Exponentiation	2
*	Multiplication	3
/	Division	3
+	Addition	4
–	Subtraction	4

Parentheses

- Needed so that the mathematical operations are performed on the proper collections of quantities and in their proper order.

- Within each set of parentheses the mathematical operation are performed from left to right on quantities at the same hierarchical level.

  These rules can help minimize the number of parentheses.

Some Examples

Mathematical expression	MATLAB expression
$1 - dc^{x+2}$	
$dc^{x} + 2$	
$(2/d)c^{x+2}$	
$(dc^{x} + 2)/g^{2.7}$	
$\sqrt{dc^{x} + 2}$	

Some Examples

Mathematical expression	**MATLAB expression**
$1 - dc^{x+2}$	1-d*c^(x+2)
$dc^{x} + 2$	d*c^x+2 or 2+d*c^x
$(2/d)c^{x+2}$	(2/d)*c^(x+2) or 2/d*c^(x+2) or 2*c^(x+2)/d
$(dc^{x} + 2)/g^{2.7}$	(d*c^x+2)/g^2.7
$\sqrt{dc^{x} + 2}$	`sqrt`(d*c^x+2) or (d*c^x+2)^0.5

Another Example

Consider

$$t = \left(\frac{1}{1 + px} \right)^{k}$$

The MATLAB script is

```
p = 7.1;  x = 4.92;  k = –1.7; % Numerical values
                               %  must be assigned first
t = (1/(1+p*x))^k
```

which results in

```
t =
  440.8779
```

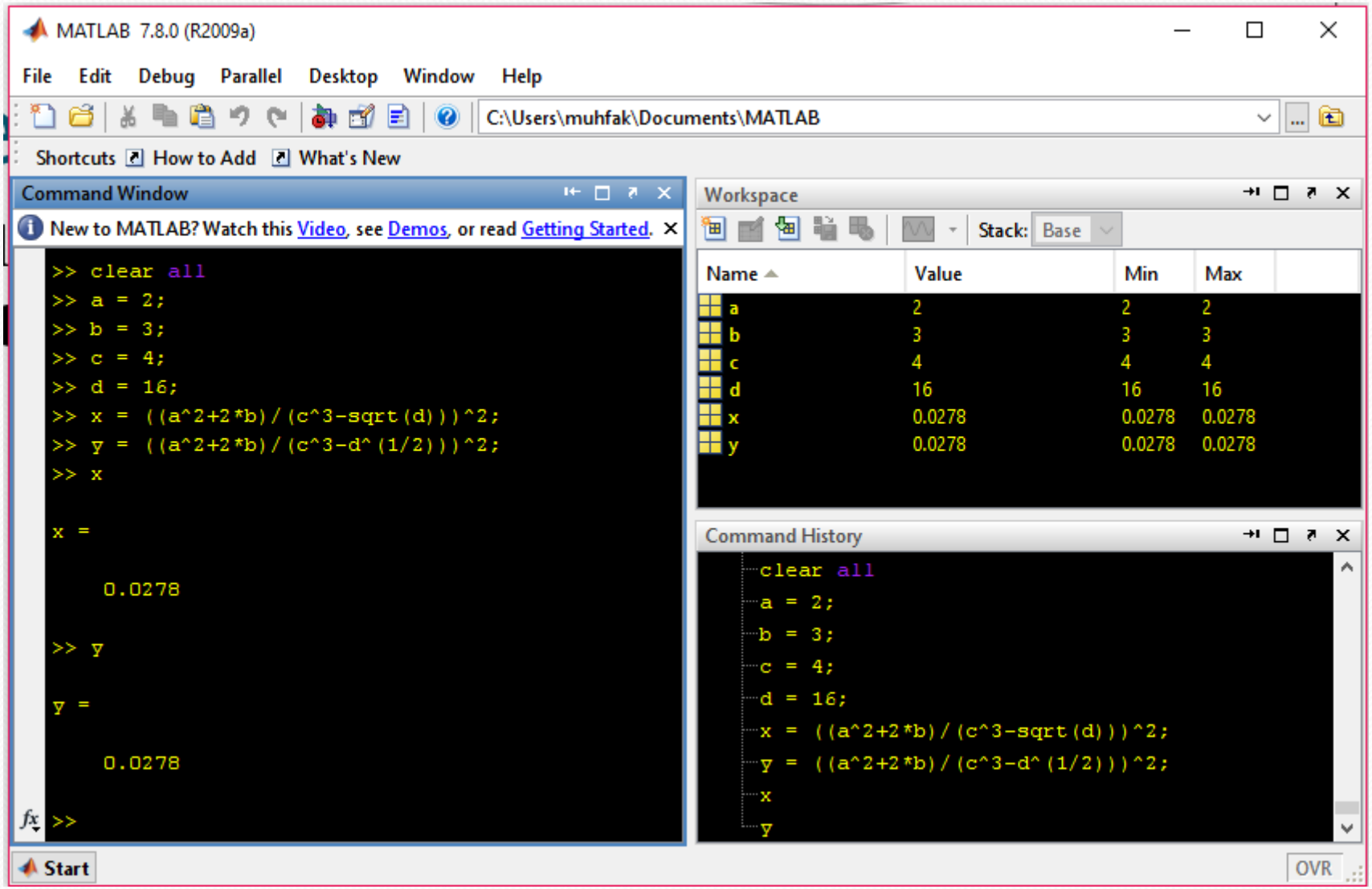
Exercise 1

- Calculate the following expression for

a=2, b=3, c=4, d=16

$$x = \left(\frac{a^2 + 2b}{c^3 - \sqrt{d}} \right)^2$$

Exercise 1


MATLAB 7.8.0 (R2009a)
File Edit Debug Parallel Desktop Window Help
C:\Users\muhfak\Documents\MATLAB
Shortcuts How to Add What's New
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.
>> clear all
>> a = 2;
>> b = 3;
>> c = 4;
>> d = 16;
>> x = ((a^2+2*b)/(c^3-sqrt(d)))^2;
>> y = ((a^2+2*b)/(c^3-d^(1/2)))^2;
>> x
x =
0.0278
>> y
y =
0.0278
>>
Workspace
Stack: Base
Name Value Min Max
a 2 2 2
b 3 3 3
c 4 4 4
d 16 16 16
x 0.0278 0.0278 0.0278
y 0.0278 0.0278 0.0278
Command History
clear all
a = 2;
b = 3;
c = 4;
d = 16;
x = ((a^2+2*b)/(c^3-sqrt(d)))^2;
y = ((a^2+2*b)/(c^3-d^(1/2)))^2;
x
y
Start
OVR

Examples

(1) Complex Numbers: $z = a + 1jb$ or $z = a + 1ib$ ($i = j = \sqrt{-1}$)

Example

```
a = 2;  b = 3;
z = (a+1j*b)*(4-7j)
```

Note:

Real and complex numbers can be mixed without any special concerns.

Example 1

```
z = 4 + sqrt(-4)
```

System displays

```
z =
   4.0000 + 2.0000i
```

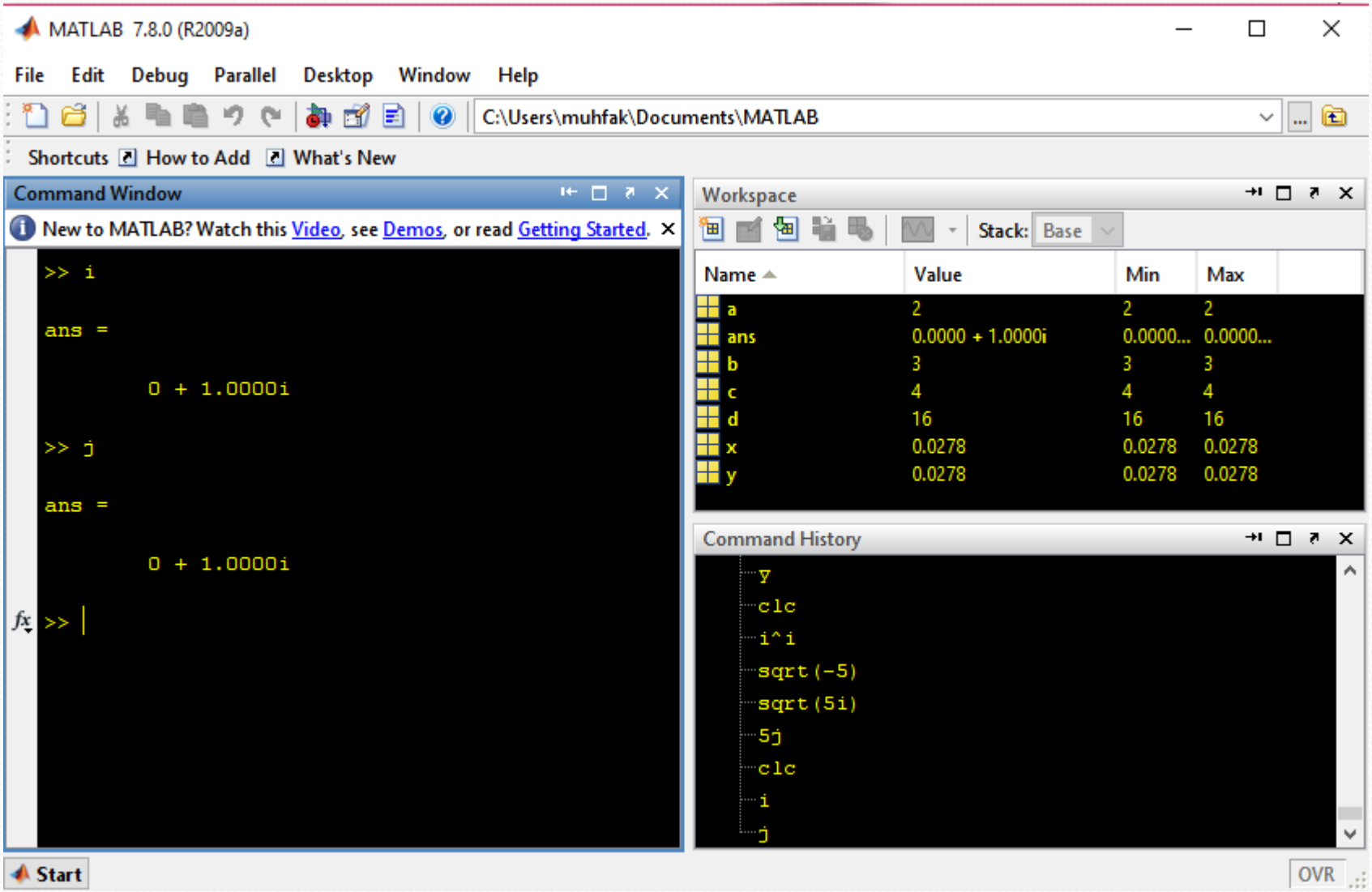
Example 2

```
z = 1i^1i
```

System displays

```
z =
   0.2079
```

Examples


MATLAB 7.8.0 (R2009a)
File Edit Debug Parallel Desktop Window Help
C:\Users\muhfak\Documents\MATLAB
Shortcuts How to Add What's New
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.
>> i
ans =
0 + 1.0000i
>> j
ans =
0 + 1.0000i
>>
Workspace
Stack: Base
Name Value Min Max
a 2 2 2
ans 0.0000 + 1.0000i 0.0000... 0.0000...
b 3 3 3
c 4 4 4
d 16 16 16
x 0.0278 0.0278 0.0278
y 0.0278 0.0278 0.0278
Command History
y
clc
i^i
sqrt(-5)
sqrt(5i)
5j
clc
i
j
Start
OVR

(2) Exponential Form: $x = 4.56\times10^{-2}$

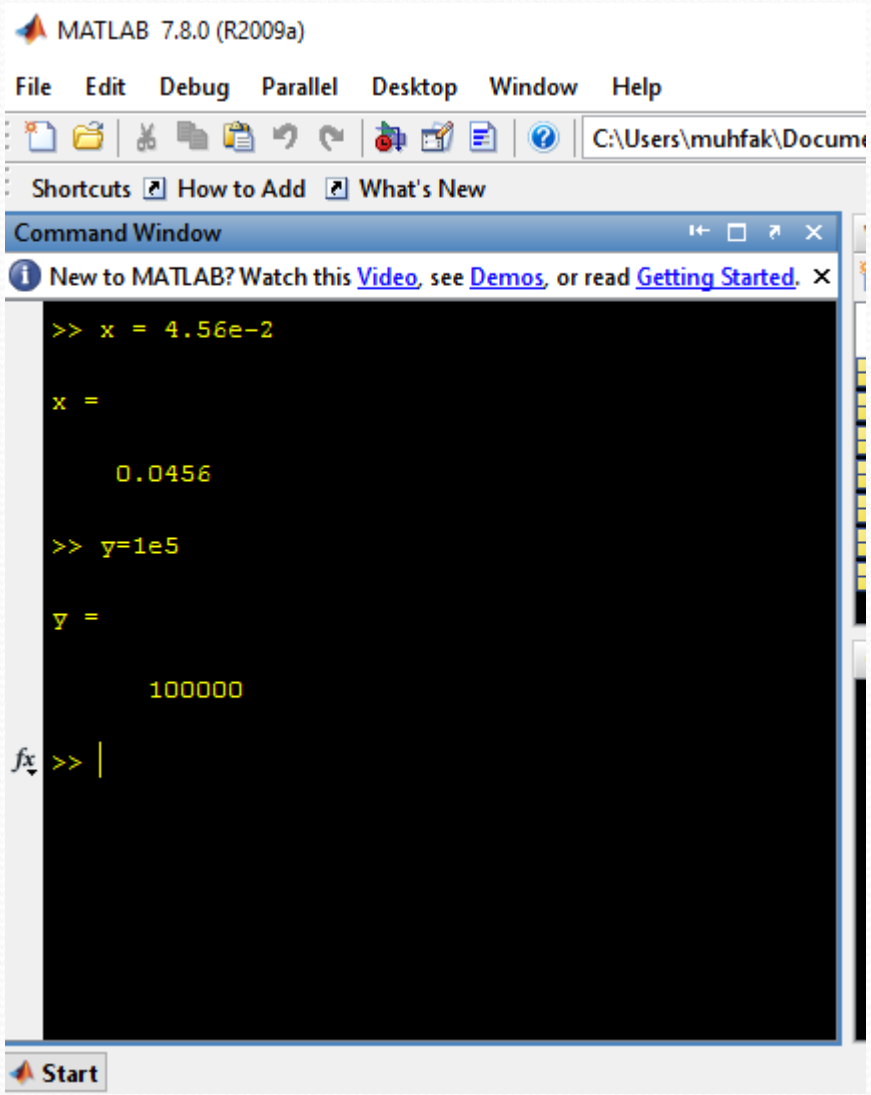
x = 4.56e-2

or

x = 0.0456

or

x = 4.56*10^-2



System Assignment of Variable Names

Type in the command window

```
cos(pi/3)
```

The system responds with

```
ans =

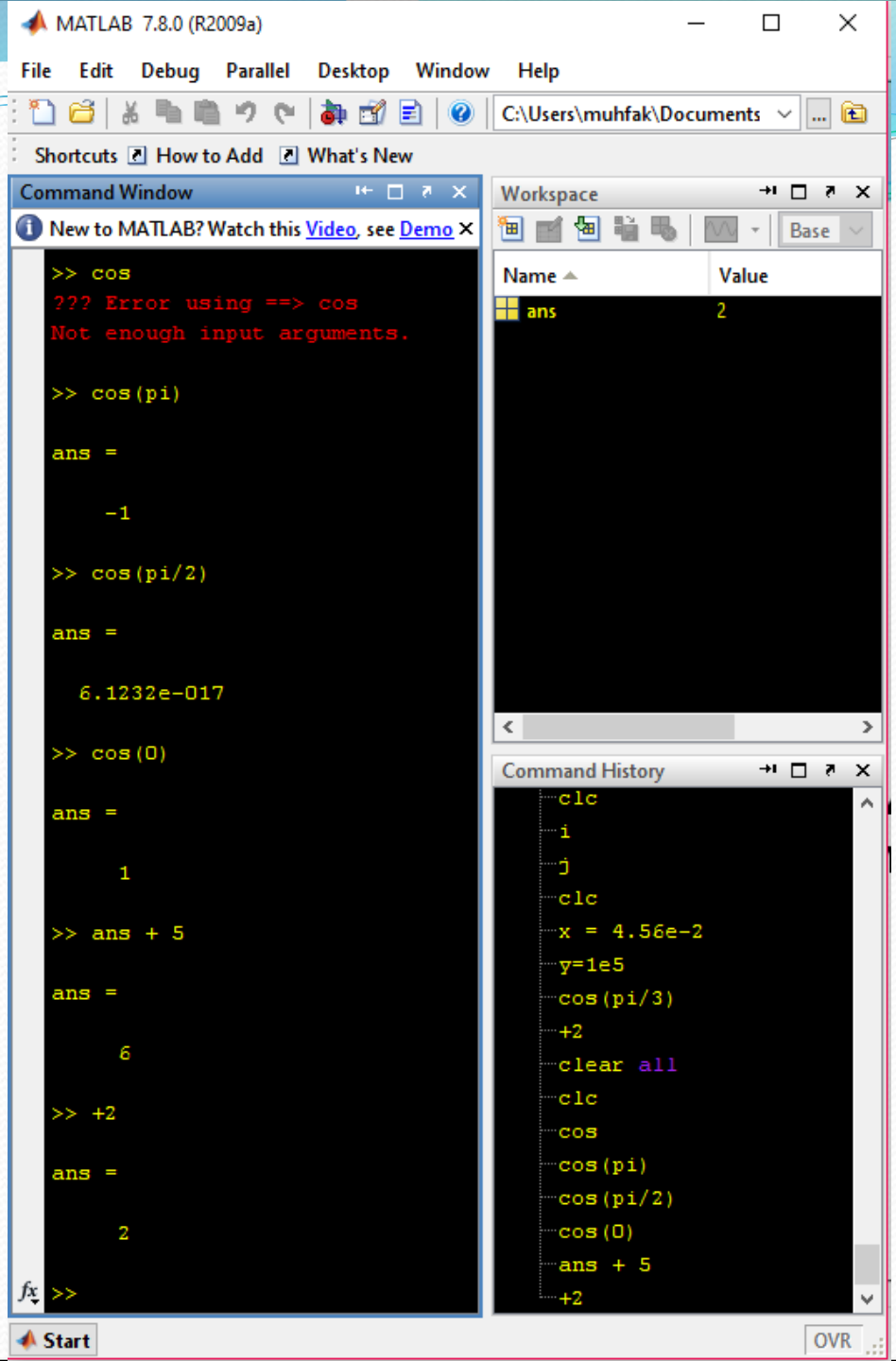
    0.5000
```

The variable *ans* can now be used as one would any other variable. Then, typing in the command window

```
ans+2
```

the system responds with

```
ans =
    2.5000
```


MATLAB 7.8.0 (R2009a)
File Edit Debug Parallel Desktop Window Help
C:\Users\muhfak\Documents
Shortcuts How to Add What's New
Command Window
New to MATLAB? Watch this Video, see Demo
>> cos
??? Error using ==> cos
Not enough input arguments.
>> cos(pi)
ans =
-1
>> cos(pi/2)
ans =
6.1232e-017
>> cos(0)
ans =
1
>> ans + 5
ans =
6
>> +2
ans =
2
>>
Workspace
Base
Name
Value
ans
2
Command History
clc
i
j
clc
x = 4.56e-2
y=1e5
cos(pi/3)
+2
clear all
clc
cos
cos(pi)
cos(pi/2)
cos(0)
ans + 5
+2
Start
OVR

Some Elementary MATLAB Functions

Mathematical function	MATLAB expression
e^x	`exp(x)`
$e^x - 1 \quad x << 1$	`expm1(x)`
$\sqrt{x}$	`sqrt(x)`
$\ln(x)$ or $\log_e(x)$	`log(x)`
$\log_{10}(x)$	`log10(x)`
$\lvert x \rvert$	`abs(x)`
signum(x)	`sign(x)`
$\log_e(1+x) \quad x << 1$	`log1p(x)`
$n!$	`factorial(n)`
All prime numbers $\leq n$	`primes(n)`

Some MATLAB Constants and Special Quantities

Mathematical quantity or operation	MATLAB expression	Comments
π	`pi`	3.141592653589793
$\sqrt{-1}$	`i` or `j`	Indicates complex quantity.
Floating point relative accuracy	`eps`	$\approx 2.22\times10^{-16}$
∞	`inf`	Infinity
0/0, $0\times\infty$, ∞/∞	`NaN`	Undefined mathematical operation
Largest floating-point number before overflow	`realmax`	≈ 1.7977e+308
Smallest floating-point number before underflow	`realmin`	≈ 2.2251e-308

MATLAB Trigonometric and Hyperbolic Functions

	Trigonometric			Hyperbolic	
Function	**(radians)**	**(degrees)**	**Inverse**		**Inverse**
sine	`sin(x)`	`sind(x)`	`asin(x)`	`sinh(x)`	`asinh(x)`
cosine	`cos(x)`	`cosd(x)`	`acos(x)`	`cosh(x)`	`acosh(x)`
tangent	`tan(x)`	`tand(x)`	`atan(x)`†	`tanh(x)`	`atanh(x)`
secant	`sec(x)`	`secd(x)`	`asec(x)`	`sech(x)`	`asech(x)`
cosecant	`csc(x)`	`cscd(x)`	`acsc(x)`	`csch(x)`	`acsch(x)`
cotangent	`cot(x)`	`cotd(x)`	`acot(x)`	`coth(x)`	`acoth(x)`

† `atan2(y, x)` is the four quadrant version.

Several Specialized Statistical Functions

Mathematical function	MATLAB Expression	Description
maximum value of x	`max(x)`	Largest element(s) in an array
μ	`mean(x)`	Average or mean value of an array
median	`median(x)`	Median value of an array
minimum value of x	`min(x)`	Smallest element(s) in an array
mode	`mode(x)`	Most frequent values in an array
σ or s	`std(x)`	Standard deviation of an array
σ^2 or s^2	`var(x)`	Variance of an array of values

MATLAB Relational Operators

Conditional	Mathematical symbol	MATLAB symbol
equal	=	==
not equal	≠	~=
less than	<	<
greater than	>	>
less than or equal	≤	<=
greater than or equal	≥	>=

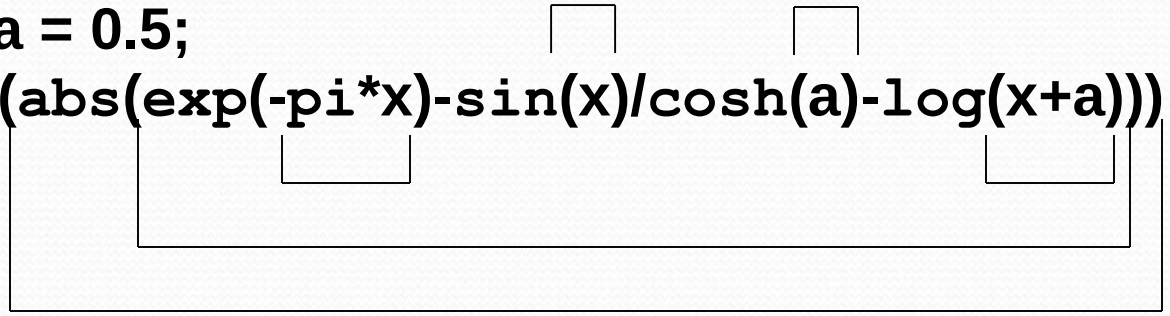
Example

For $x = 0.1$ and $a = 0.5$, determine the value of y when

$$y = \sqrt{\left| e^{(-\pi x)} - \sin(x)/\cosh(a) - \ln_e(x + a) \right|}$$

The script is

```
x = 0.1;  a = 0.5;
y = sqrt(abs(exp(-pi*x)-sin(x)/cosh(a)-log(x+a)))
```



When executed, the system returns

```
y =
   1.0736
```

Keywords Reserved Explicitly for the MATLAB Programming Language

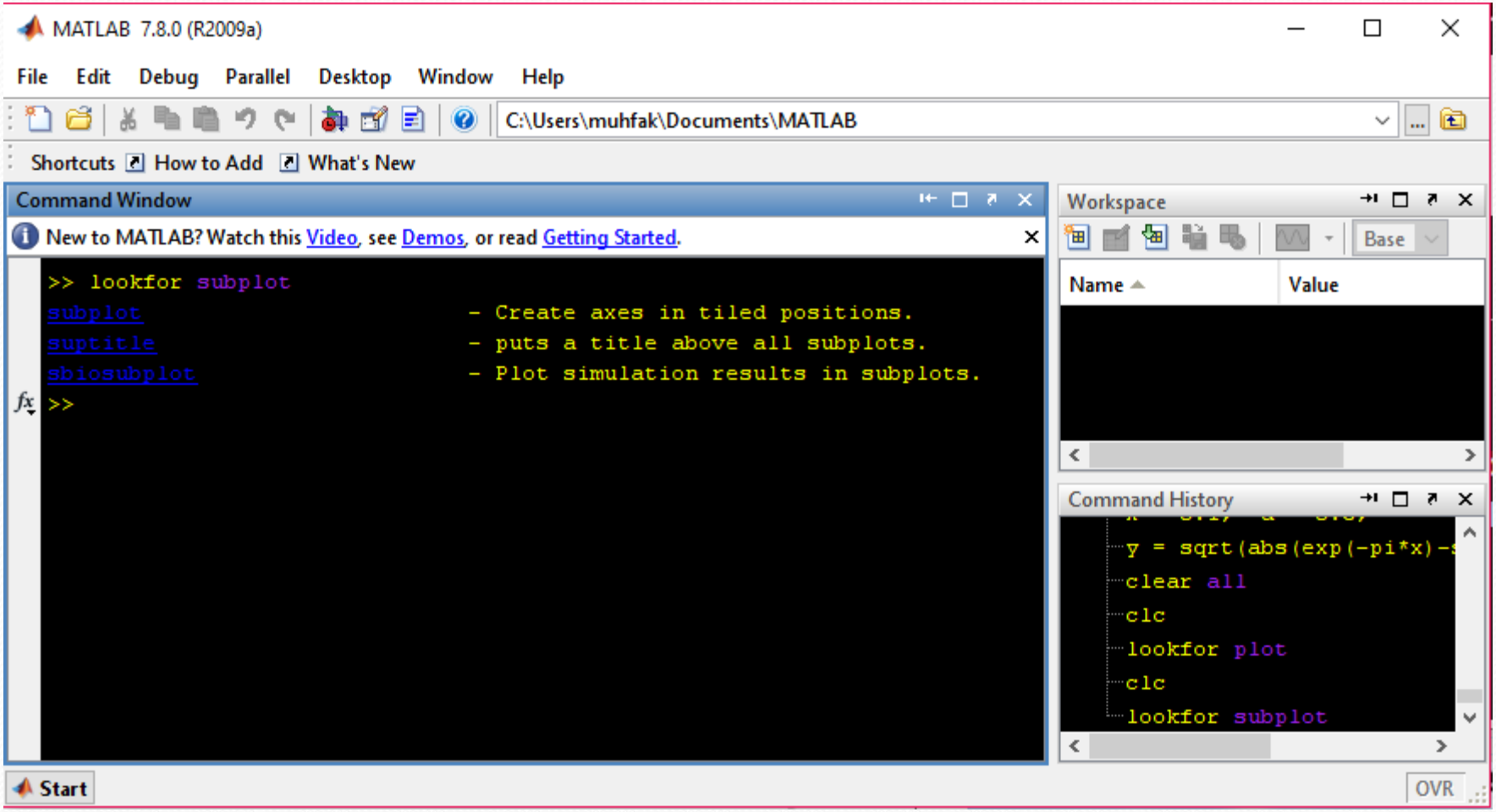
`break`	`global`
`case`	`if`
`catch`	`otherwise`
`continue`	`persistent`
`else`	`return`
`elseif`	`switch`
`end`	`try`
`for`	`while`
`function`	

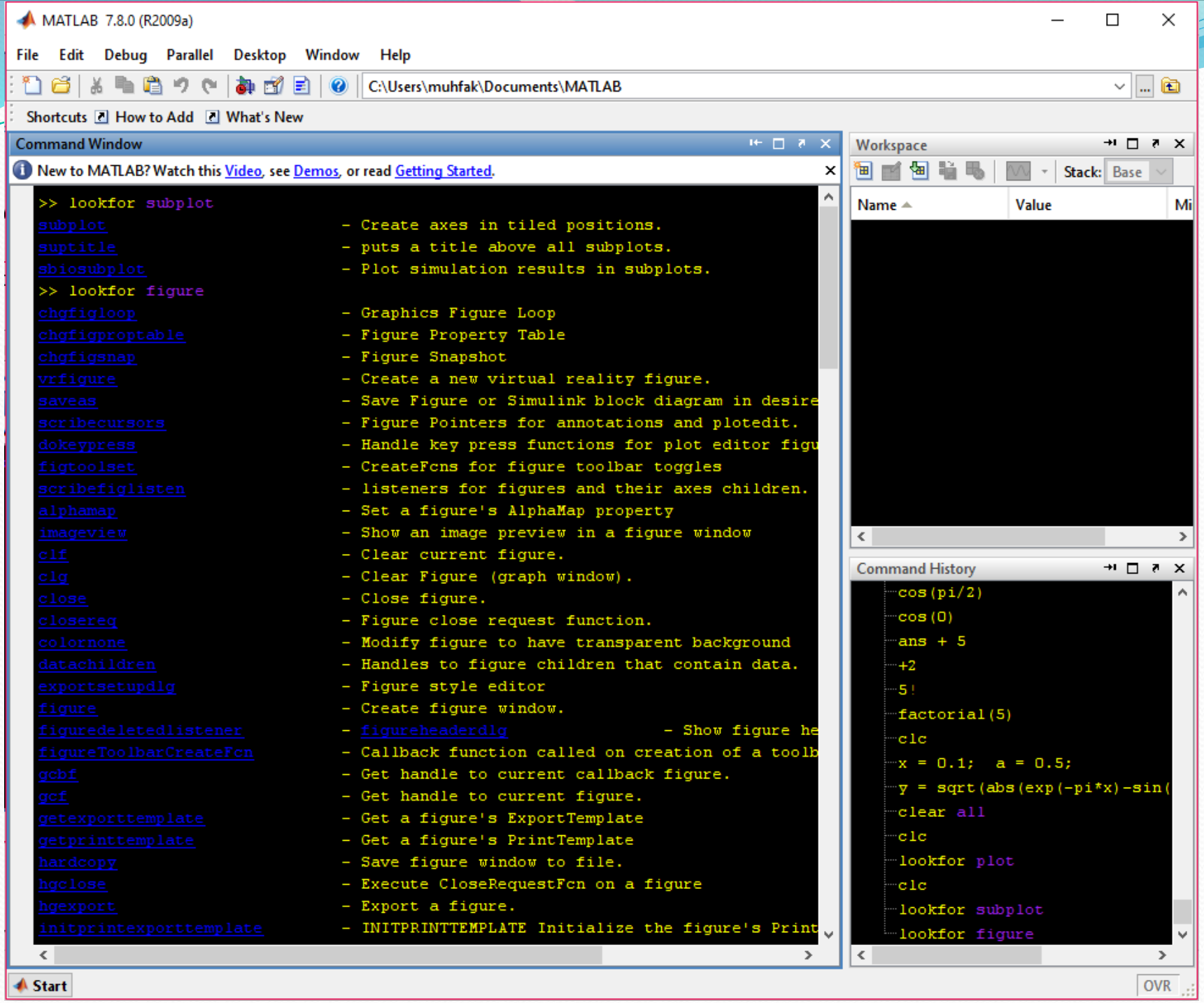
Some Suggestions on How to Use MATLAB

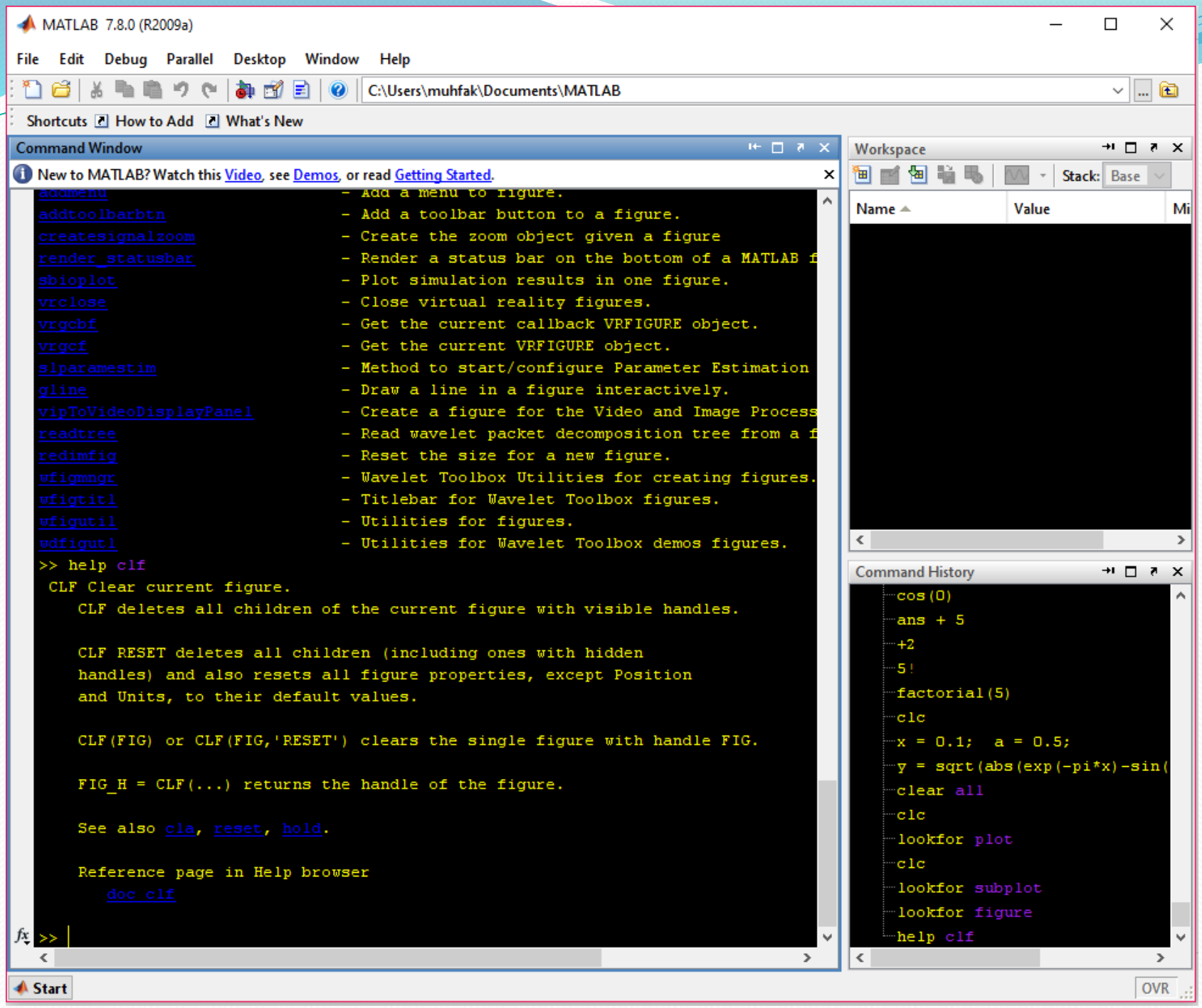
- *Use the Help files extensively.*
- *Write scripts and functions in a text editor and save them as M files.*
- *Attempt to minimize the number of expressions comprising scripts and functions.*
- *When practical, use graphical output as the script or function is being developed.*

- *Use the Help files extensively.*

  'Lookfor ' and 'Help' commands




MATLAB 7.8.0 (R2009a)
File Edit Debug Parallel Desktop Window Help
C:\Users\muhfak\Documents\MATLAB
Shortcuts How to Add What's New
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.
>> lookfor subplot
subplot - Create axes in tiled positions.
suptitle - puts a title above all subplots.
sbiosubplot - Plot simulation results in subplots.
>> lookfor figure
chgfigloop - Graphics Figure Loop
chgfigproptable - Figure Property Table
chgfigsnap - Figure Snapshot
vrfigure - Create a new virtual reality figure.
saveas - Save Figure or Simulink block diagram in desire
scribecursors - Figure Pointers for annotations and plotedit.
dokeypress - Handle key press functions for plot editor figu
figtoolset - CreateFcns for figure toolbar toggles
scribefiglisten - listeners for figures and their axes children.
alphamap - Set a figure's AlphaMap property
imageview - Show an image preview in a figure window
clf - Clear current figure.
clg - Clear Figure (graph window).
close - Close figure.
closereq - Figure close request function.
colornone - Modify figure to have transparent background
datachildren - Handles to figure children that contain data.
exportsetupdlg - Figure style editor
figure - Create figure window.
figuredeletedlistener - figureheaderdlg - Show figure he
figureToolbarCreateFcn - Callback function called on creation of a toolb
gcbf - Get handle to current callback figure.
gcf - Get handle to current figure.
getexporttemplate - Get a figure's ExportTemplate
getprinttemplate - Get a figure's PrintTemplate
hardcopy - Save figure window to file.
hgclose - Execute CloseRequestFcn on a figure
hgexport - Export a figure.
initprintexporttemplate - INITPRINTTEMPLATE Initialize the figure's Print
Workspace
Stack: Base
Name Value Mi
Command History
cos(pi/2)
cos(0)
ans + 5
+2
5!
factorial(5)
clc
x = 0.1; a = 0.5;
y = sqrt(abs(exp(-pi*x)-sin(
clear all
clc
lookfor plot
clc
lookfor subplot
lookfor figure
Start
OVR


MATLAB 7.8.0 (R2009a)
File Edit Debug Parallel Desktop Window Help
C:\Users\muhfak\Documents\MATLAB
Shortcuts How to Add What's New
Command Window
New to MATLAB? Watch this Video, see Demos, or read Getting Started.
addmenu - Add a menu to figure.
addtoolbarbtn - Add a toolbar button to a figure.
createsignalzoom - Create the zoom object given a figure
render_statusbar - Render a status bar on the bottom of a MATLAB f
sbioplot - Plot simulation results in one figure.
vrclose - Close virtual reality figures.
vrgcbf - Get the current callback VRFIGURE object.
vrgcf - Get the current VRFIGURE object.
slparamestim - Method to start/configure Parameter Estimation
gline - Draw a line in a figure interactively.
vipToVideoDisplayPanel - Create a figure for the Video and Image Process
readtree - Read wavelet packet decomposition tree from a f
redimfig - Reset the size for a new figure.
wfigmngr - Wavelet Toolbox Utilities for creating figures.
wfigtitl - Titlebar for Wavelet Toolbox figures.
wfigutil - Utilities for figures.
wdfigutl - Utilities for Wavelet Toolbox demos figures.
>> help clf
CLF Clear current figure.
CLF deletes all children of the current figure with visible handles.
CLF RESET deletes all children (including ones with hidden
handles) and also resets all figure properties, except Position
and Units, to their default values.
CLF(FIG) or CLF(FIG,'RESET') clears the single figure with handle FIG.
FIG_H = CLF(...) returns the handle of the figure.
See also cla, reset, hold.
Reference page in Help browser
doc clf
>>
Workspace
Stack: Base
Name Value Mi
Command History
cos(0)
ans + 5
+2
5!
factorial(5)
clc
x = 0.1; a = 0.5;
y = sqrt(abs(exp(-pi*x)-sin(
clear all
clc
lookfor plot
clc
lookfor subplot
lookfor figure
help clf
Start
OVR

EE214 – Computer Aided Engineering Applications

End of Lecture 1